Table of Contents

Volume 30 Time Series

Preface to Handbook – 30 xiii

Contributors: Vol. 30 xvii

Part I. Bootstrap and Tests for Linearity of a Time Series 1

Ch. 1. Bootstrap Methods for Time Series 3
Jens-Peter Kreiss and Soumendra Nath Lahiri

1. Introduction 3
2. Residual bootstrap for parametric and nonparametric models 6
3. Autoregressive-sieve bootstrap 9
4. Bootstrap for Markov chains 11
5. Block bootstrap methods 13
6. Frequency domain bootstrap methods 16
7. Mixture of two bootstrap methods 17
8. Bootstrap under long-range dependence 21
   Acknowledgment 23
   References 23

Ch. 2. Testing Time Series Linearity: Traditional and Bootstrap Methods 27
Arthur Berg, Timothy McMurry and Dimitris N. Politis

1. Introduction 27
2. A brief survey of linearity and Gaussianity tests 28
3. Linear and nonlinear time series 30
4. AR-sieve bootstrap tests of linearity 33
5. Subsampling tests of linearity 35
   References 40

Ch. 3. The Quest for Nonlinearity in Time Series 43
Simone Giannerini

1. Introduction 43
2. Defining a linear process 45
3. Testing for nonlinearity 48
4. Conclusions 59
Acknowledgments 60
References 60

Part II. Nonlinear Time Series 65

Ch. 4. Modelling Nonlinear and Nonstationary Time Series 67
Dag Tjøstheim

1. Introduction 67
2. Nonlinear stationary models 68
3. Linear nonstationarity 75
4. Nonlinear and nonstationary processes 79
5. Time-varying parameters and state-space models 90
References 93

Ch. 5. Markov Switching Time Series Models 99
Jürgen Franke

1. Introduction 99
2. Markov switching autoregressions 101
3. Other Markov switching time series models 117
4. Markov switching in continuous time 118
Acknowledgments 119
References 120

Ch. 6. A Review of Robust Estimation under Conditional Heteroscedasticity 123
Kanchan Mukherjee

1. Introduction 123
2. GARCH (p, q) and GJR $(1, 1)$ models 125
3. Data analysis for the GARCH and GJR models 131
4. Value at risk and M-tests 134
5. Data analysis based on VaR 137
6. Nonlinear AR–ARCH model 142
7. Data analysis for the AR–ARCH model 150
8. Conclusions 153
Acknowledgments 153
References 153

Part III. High Dimensional Time Series 155

Ch. 7. Functional Time Series 157
Siegfried Hörmann and Piotr Kokoszka

1. Introduction 157
2. The Hilbert space model for functional data 160
3. Functional autoregressive model 166
4. Weakly dependent functional time series 175
5. Further reading 184
Acknowledgments 184
References 185

Ch. 8. Covariance Matrix Estimation in Time Series 187
Wei Biao Wu and Han Xiao

1. Introduction 187
2. Asymptotics of sample covariances 189
3. Low-dimensional covariance matrix estimation 193
4. High-dimensional covariance matrix estimation 200
Acknowledgments 206
References 206

Part IV. Time Series and Quantile Regression 211

Ch. 9. Time Series Quantile Regressions 213
Zhijie Xiao

1. An introduction to quantile regression 213
2. Quantile regression for autoregressive time series 215
3. Quantile regression for ARCH and GARCH models 224
4. Quantile regressions with dependent errors 229
5. Nonparametric and semiparametric QR models 231
6. Other dynamic quantile models 237
7. Extremal quantile regressions 240
8. Quantile regression for nonstationary time series 242
9. Time series quantile regression applications 247
10. Conclusion 255
Acknowledgment 255
References 255

Part V. Biostatistical Applications 259

Ch. 10. Frequency Domain Techniques in the Analysis of DNA Sequences 261
David S. Stoffer

1. Introduction 261
2. The spectral envelope 267

3. Local spectral envelope 274
4. Detection of genomic differences 283
Appendix: Principal component and canonical correlation analysis for time series 289
Acknowledgment 293
References 293

Ch. 11. Spatial Time Series Modeling for fMRI Data Analysis in Neurosciences 297
Tohru Ozaki

1. Introduction 297
2. A traditional approach: Spatial and temporal covariance functions 298
3. SPM and the implied determinism 299
4. Innovation approach and the NN-ARX model 302
5. Likelihood and the significance of the assumptions 304
6. Applications to connectivity study and brain mapping 310
7. Concluding remarks 311
Acknowledgement 312
References 312

Ch. 12. Count Time Series Models 315
Konstantinos Fokianos

1. Introduction 315
2. Poisson regression modeling 317
3. Poisson regression models for count time series 319
4. Other regression models for count time series 334
5. Integer autoregressive models 337
6. Conclusions 343
Appendix 343
Acknowledgments 344
References 344

Part VI. Nonstationary Time Series 349

Ch. 13. Locally Stationary Processes 351
Rainer Dahlhaus

1. Introduction 351
2. Time varying autoregressive processes – A deep example 353
3. Local likelihoods, derivative processes, and nonlinear models with time varying parameters 367
4. A general definition, linear processes and time varying spectral densities 379

5. Gaussian likelihood theory for locally stationary processes 387
6. Empirical spectral processes 393
7. Additional topics and further references 402
Acknowledgment 408
References 408

Ch. 14. Analysis of Multivariate Nonstationary Time Series Using the Localized Fourier Library 415
Hernando Ombao

1. Introduction 415
2. Overview of SLEX analysis 419
3. Selecting the best SLEX signal representation 424
4. Classification and discrimination of time series 432
5. Summary 442
Acknowledgments 442
References 442

Ch. 15. An Alternative Perspective on Stochastic Coefficient Regression Models 445
Suhasini Subba Rao

1. Introduction 446
2. The stochastic coefficient regression model 447
3. The estimators 450
4. Testing for randomness of the coefficients in the SCR model 453
5. Asymptotic properties of the estimators 456
6. Real data analysis 465
Acknowledgments 473
References 473

Part VII. Spatio-Temporal Time Series 475

Ch. 16. Hierarchical Bayesian Models for Space–Time Air Pollution Data 477
Sujit K. Sahu

1. Introduction 477
2. Hierarchical models 479
3. Prediction details 484
4. An example 485
5. Further discussion 492
Acknowledgment 492
Appendix: Conditional distributions for Gibbs sampling 492
References 494

Ch. 17. Karhunen–Loéve Expansion of Temporal and Spatio-Temporal Processes 497
Lara Fontanella and Luigi Ippoliti

1. Introduction 497
2. Karhunen–Loéve expansion of one-dimensional processes 498
3. Multiresolution Karhunen–Loéve 505
4. Karhunen–Loéve expansion of coupled one-dimensional processes 510
5. Karhunen–Loéve expansion of spatio-temporal processes 513
6. Discussion 517
   Acknowledgments 518
   References 518

Ch. 18. Statistical Analysis of Spatio-Temporal Models and Their Applications 521
T. Subba Rao and Gy. Terdik

1. Introduction and basic ideas 522
2. Measures for linear dependence and linearity of stationary spatial process 527
3. Models for spatial processes defined on lattices 529
4. Frequency domain approach for the estimation of CAR models 530
5. Spatio-temporal processes 531
6. Multivariate AR and STAR models 534
   Concluding Remarks 538
   Acknowledgements 539
   References 539

Part VIII. Continuous Time Series 541

Ch. 19. Lévy-Driven Time Series Models for Financial Data 543
Peter Brockwell and Alexander Lindner

1. Introduction 543
2. Lévy processes 544
3. Lévy-driven CARMA(p, q) processes 545
4. A continuous-time stochastic volatility model 549
5. Integrated CARMA processes and spot volatility modeling 550
6. Generalized Ornstein–Uhlenbeck processes 555
7. Continuous-time GARCH processes 558
   Acknowledgments 561
   References 561

Ch. 20. Discrete and Continuous Time Extremes of Stationary Processes 565
K.F. Turkman

1. Introduction 565
2. Conditions and main results 571

3. Periodogram 578
Acknowledgment 581
References 581

Part IX. Spectral and Wavelet Methods 583

Ch. 21. The Estimation of Frequency 585
Barry G. Quinn

1. Introduction 585
2. Basic model 586
3. Properties of the periodogram maximizer 590
4. Links with ARMA processes 591
5. Autoregressive approximation 592
6. Pisarenko's technique 596
7. MUSIC 599
8. An efficient technique based on ARMA filtering 600
9. Maximizing the periodogram: practicalities 604
10. Discrete Fourier transform-based methods 606
11. Estimation using only the moduli of the DFT 608
12. More than one sinusoid 610
13. Complex sinusoids 618
14. Related problems and areas 619
References 619

Ch. 22. A Wavelet Variance Primer 623
Donald B. Percival and Debashis Mondal

1. Introduction 623
2. Maximal overlap discrete wavelet transform 625
3. Analysis of variance via the MODWT 628
4. Definition and basic properties of wavelet variance 630
5. Basic estimators of the wavelet variance 632
6. Specialized estimators of the wavelet variance 637
7. Combining wavelet variance estimators across scales 641
8. Examples 645
9. Concluding remarks 653
Acknowledgments 654
References 654

Part X. Computational Methods 659

Ch. 23. Time Series Analysis with R 661
A. Ian McLeod, Hao Yu and Esam Mahdi

1. Time series plots 663
2. Base packages: stats and datasets 668

3. More linear time series analysis 671
4. Time series regression 677
5. Nonlinear time series models 683
6. Unit-root tests 685
7. Cointegration and VAR models 693
8. GARCH time series 694
9. Wavelet methods in time series analysis 696
10. Stochastic differential equations (SDEs) 699
11. Conclusion 700
Acknowledgments 702
A. Appendix 702
References 707

Index 713

Handbook of Statistics: Contents of Previous Volumes 727